# Section 5. Renewable Energy Sources

Prices and expenditures for renewable energy sources are based on consumption estimates from the State Energy Data System (SEDS). Renewable energy sources reported in SEDS include estimates of wood and waste in all sectors, hydroelectric power in the industrial and commercial sectors, and the electric power sector's use of hydropower and geothermal, wind, wood, waste, photovoltaic and solar thermal energy. SEDS also includes, for 1989 forward, the residential and commercial sectors' use of geothermal and solar energy and industrial sector's use of geothermal energy.

## Fuel Ethanol

Beginning in 1993, fuel ethanol blended into motor gasoline is included in SEDS motor gasoline consumption volumes. For these years, the price and expenditure estimates for finished motor gasoline include the fuel ethanol blended into motor gasoline. For all available years, expenditure estimates for fuel ethanol are available separately for informational purposes and are estimated by assigning motor gasoline prices to the fuel ethanol quantities blended into motor gasoline. Prior to 1993, fuel ethanol estimates are added separately from motor gasoline for calculating total energy expenditures in SEDS.

## Hydroelectric, Geothermal, Wind, Photovoltaic, and Solar Thermal Energy

In SEDS, it is assumed that there are no direct fuel costs for hydroelectric, geothermal, wind, photovoltaic, or solar thermal energy. SEDS consumption values are adjusted by removing these energy sources before calculating energy expenditures, as described in Section 7, "Consumption Adjustments for Calculating Expenditures," at http://www.eia.gov/emeu/states/_seds_tech_notes.html.

## Wood and Waste

Prices are estimated for wood and waste in SEDS. Wood includes wood and wood-derived fuels. Waste is biomass waste which includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural byproducts, etc. Prior to 2001, waste also includes non-biomass waste (municipal sold waste from non-biogenic sources, and tire-derived fuel). It is assumed that taxes are included in the prices reported on the U.S. Energy Information Administration (EIA) "Residential Energy Consumption Survey," the "Manufacturing Energy Consumption Survey," and the various electric power survey forms that are used as the basis for the SEDS price estimates.

## Residential Sector

### *Physical Unit Prices, All Years*

Prices paid for wood by the residential sector for 1970 forward are based on unpublished data from the Form EIA-457, "Residential Energy Consumption Survey, Fall-Winter 1980–1981" (RECS 1980), and the "1993 Residential Energy Consumption Survey" (RECS 1993). The nine Census division average prices for residential wood from RECS 1980 are used to estimate prices for 1970 through 1989. The 1980 Census division residential wood prices are adjusted in proportion to the changes in U.S. average residential distillate fuel oil prices each year compared to the 1980 distillate fuel oil price. The Census division estimated prices are assigned to the States within each Census division for 1970 through 1989. The four Census region average prices for residential wood from RECS 1993 are used to estimate prices for 1990 forward. The 1993 Census division wood prices are adjusted in proportion to the changes in U.S. average residential distillate fuel oil prices each year compared to the 1990 distillate fuel oil price. The estimated Census region wood prices are assigned to the States within each Census region for 1990 forward.

### *Btu Prices, All Years*

Prices in dollars per cord are converted to dollars per million Btu using the conversion factor of 20 million Btu per cord.

### *Data Sources*

#### Prices

1990 forward: EIA, unpublished data from Form EIA-457, "1993 Residential Energy Consumption Survey," http://www.eia.gov/emeu/recs/contents.html, Census region compilation of the answers to questions J-28 and J-33 through J-36.

1970–1989: EIA, unpublished data from Form EIA-457, "Residential Energy Consumption Survey, Fall-Winter 1980–1981" Census division compilation of data on average prices paid for wood.

1970 forward: EIA, U.S. average residential distillate fuel oil prices (DFRCDUS) from SEDS.

#### Consumption

1970 forward: EIA, State Energy Data System, residential wood consumption adjusted as described in Section 7, "Consumption Adjustments for Calculating Expenditures," at http://www.eia.gov/emeu/states/_seds_tech_notes.html.

### *Conversion Factor*

20 million Btu per cord.

## Commercial Sector

### *Btu Prices, 1989 Forward*

Wood consumption in the commercial sector is estimated for two groups—commercial combined-heat-and-power (CHP) and electricity-only facilities, and other commercial entities. State-level wood prices are not available for either of these two groups. The SEDS electric power sector annual average U.S. price for wood is calculated and assigned to the CHP and electricity-only facilities' consumption each year. The State-level residential wood prices are assigned to the other commercial entities.

Waste is consumed in the commercial sector by commercial CHP and electricity-only facilities only. States with commercial waste consumption are assigned the electric power sector annual average U.S. price for waste.

The State-level commercial sector wood and waste prices are consumption-weighted averages of the consumption and prices of the individual components. The consumption data are adjusted to account for quantities obtained at no cost. (See the discussion in Section 7, "Consumption Adjustments for Calculating Expenditures," at http://www.eia.gov/emeu/states/_seds_tech_notes.html.

### *Btu Prices, 1970 through 1988*

Wood and waste consumption and prices are not available for commercial CHP and electricity-only facilities prior to 1989. States with commercial wood consumption are assigned the State-level residential wood price.

### *Data Sources*

**Prices**

1989 forward: EIA, U.S. average consumption-weighted electric power wood and waste prices (WDEIDUS and WSEIDUS) from SEDS.

1970 forward: EIA, State-level residential wood prices (WDRCD) from SEDS.

**Consumption**

1970 forward: EIA, State Energy Data System, commercial wood and waste consumption adjusted as described in Section 7, "Consumption Adjustments for Calculating Expenditures," at http://www.eia.gov/emeu/states/_seds_tech_notes. html.

## Industrial Sector

The industrial sector price estimates for wood and waste combined in SEDS are developed by dividing industrial sector consumers into two groups—manufacturing industries and combined heat and power (CHP) and electricity-only facilities. For the manufacturing industries, wood and waste consumption is estimated separately by the types of wood and waste within the NAICS categories based on data from the EIA "Manufacturing Energy Consumption Survey" and the U.S. Bureau of the Census, economic surveys by industry. The State-level industrial sector wood and waste prices are consumption-weighted averages of the consumption and prices of the individual wood and waste components of each of the NAICS categories. The consumption data used to calculate expenditures in SEDS are adjusted to account for estimated quantities of wood and waste obtained at no cost. (See the discussion in Section 7, "Consumption Adjustments for Calculating Expenditures," at http://www.eia.gov/emeu/states/_seds_tech_notes.html.)

### *Btu Prices, 1998 Forward*

**Manufacturing Industries**

For 1998 forward, industrial sector wood and waste prices are consumption-weighted averages based on unpublished data from the Form EIA-846, "Manufacturing Energy Consumption Survey" (MECS). Data from the 1998 MECS are used for 1998 through 2001 and data from the 2002 MECS are used for 2002 forward. MECS collects data on quantities consumed and quantities purchased in million Btu and expenditures in dollars for five types of wood and waste—pulping liquor, agricultural waste, wood harvested from trees, wood refuse and byproducts from mills, and wood and paper refuse. The quantities purchased and expenditures are used to calculate average prices for each type of wood and waste. MECS also identifies consumption of the different types of wood and waste by North American Industry Classification System (NAICS). For each of the NAICS industries (311, 321, 322, 337, and other), an average wood and waste price is calculated by using the consumption of each of the five types of wood and waste to weight the average of their respective NAICS categories prices. These average prices by NAICS code are applied to the SEDS estimates of wood and waste consumption by NAICS code in each State to calculate State-level weighted average prices for 1998 forward.

**Industrial Combined-Heat-and-Power and Electricity-only Facilities**

No prices are available for quantities of wood and waste used by industrial combined heat and power (CHP) and electricity-only facilities. The SEDS electric power sector annual average State prices for wood and for waste are assigned to the industrial CHP and electricity-only facilities' consumption each year.

### *Btu Prices, 1994 through 1997*

**Manufacturing Industries**

For 1994 through 1997, industrial sector wood and waste prices are consumption-weighted averages based on unpublished data from the Form EIA-846, "1994 Manufacturing Energy Consumption Survey" (MECS 1994). MECS 1994 collects data on quantities consumed and quantities purchased in million Btu and expenditures in dollars for five types of wood and waste—pulping liquor, agricultural waste, wood harvested from trees, wood refuse and byproducts from mills, and wood and paper refuse. The quantities purchased and expenditures are used to calculate average prices for each type of wood and waste. MECS 1994 also identifies consumption of the different types of wood and waste by Standard Industrial Classification (SIC) categories 20, 24, 25, 26, and other (a subtotal of SIC codes 21 through 23 and 27 through 30). For each of the SIC codes, an average wood and waste price is calculated by using the consumption of each of the five types of wood and waste to weight the average of their respective prices. These average prices by SIC code for 1994 are applied to the SEDS estimates of wood and waste consumption by SIC code in each State to calculate State-level weighted average prices for 1994 and 1995. For 1996 and 1997, SEDS consumption and price estimates are developed using the 1997 Economic Census, which uses the North American Industry Classification System (NAICS). Data for the NAICS industries (311, 321, 322, 337, and other) are used.

**Industrial Combined-Heat-and-Power and Electricity-only Facilities**

No prices are available for quantities of wood and waste used by industrial combined-heat-and-power (CHP) and electricity-only facilities. The SEDS electric power sector annual average State prices for wood and for waste are assigned to the industrial CHP and electricity-only facilities' consumption each year.

### *Btu Prices, 1990 through 1993*

**Manufacturing Industries**

For 1990 through 1993, industrial sector wood and waste prices are consumption-weighted averages based on unpublished data from the Form EIA-846, "1991 Manufacturing Energy Consumption Survey" (MECS 1991). MECS 1991 collects data on quantities consumed and quantities purchased in million Btu and expenditures in dollars for five types of wood and waste—waste materials, pulping liquor, round wood, wood chips, and biomass. The quantities purchased and expenditures are used to calculate average prices for each type of wood and waste. MECS 1991 also identifies consumption of the different types of wood and waste by Standard Industrial Classification (SIC) categories 20, 24, 26, and other (a subtotal of SIC industries 21 through 25 and 27 through 30). For each of the SIC categories, an average wood and waste price is calculated by using the consumption of each of the five types of wood and waste to weight the average of their respective prices. These average prices by SIC code for 1991 are applied to the SEDS estimates of wood and waste consumption by SIC code in each State to calculate State-level weighted average prices for 1990 through 1993.

**Industrial Combined-Heat-and-Power and Electricity-only Facilities**

No prices are available for quantities of wood and waste used by industrial combined heat and power (CHP) and electricity-only facilities. The SEDS electric power sector annual average State prices for wood and for waste are assigned to the industrial CHP and electricity-only facilities' consumption each year.

### *Btu Prices, 1986 through 1989*

**Manufacturing Industries**

For 1986 through 1989, industrial sector wood and waste prices are consumption-weighted averages based on data from the Form EIA-846, "1988 Manufacturing Energy Consumption Survey" (MECS 1988). MECS 1988 collects data on inputs of energy for heat, power, and electricity generation and quantities purchased in billion Btu and expenditures in dollars for five types of wood and waste—waste materials, pulping liquor, round wood, wood chips, and biomass. The quantities consumed and expenditures are used to calculate average prices for each type of wood and waste. MECS 1988 also identifies consumption of the different types of wood and waste by Standard Industrial Classification (SIC) categories 20, 24, 26, and other (mainly SIC 25). For each of the SIC codes, an average wood and waste price is calculated by using the consumption of each of the five types of wood

and waste to weight the average of the respective prices. These average prices by SIC code for 1988 are applied to the SEDS estimates of wood and waste consumption by SIC code in each State to calculate State-level weighted average prices for 1986 through 1989.

**Industrial Combined-Heat-and-Power Facilities**

Information on industrial combined-heat-and-power (CHP) and electricity-only facilities' use of wood and waste became available beginning in 1989. Although quantities of wood and waste used by industrial CHP and electricity-only facilities are available for 1989, prices are not available. The SEDS electric power sector annual average prices for wood and for waste are assigned to the industrial CHP and electricity-only facilities' consumption in 1989.

### *Btu Prices, 1980 through 1985*

For 1980 through 1985, industrial sector wood and waste prices are consumption-weighted averages based on data published in the *Manufacturing Energy Consumption Survey: Consumption of Energy, 1985* (MECS 1985), Table 2. MECS 1985 contains data on inputs of energy for heat, power, and electricity generation in trillion Btu for two types of wood and waste—major byproducts and other. MECS 1985 also identifies consumption of the two types of wood and waste by the SIC categories 20, 24, 26, and other (mainly SIC 25). Since no price data were collected on MECS 1985, the average prices for each of the SIC categories developed from MECS 1988 are applied to the MECS 1985 estimates of wood and waste consumption by SIC code in each State to calculate State-level weighted average prices for 1980 through 1985.

### *Btu Prices, 1970 through 1979*

There are no data available for estimating industrial prices for wood and waste in 1970 through 1979. Therefore, the 1980 State-level average industrial sector wood and waste prices are used for all States in 1970 through 1979.

### *Data Sources*

**Prices**

1989 forward: EIA, U.S. average consumption-weighted electric power wood and waste prices (WDEIDUS and WSEIDUS) from SEDS.

2001 forward: EIA, SEDS wood and waste consumption by NAICS categories 311221, 311311, 321113, 321912, 322121, 322130, and 337122, developed from the U.S. Department of Commerce, Bureau of the Census, *2002 Economic Census*, Industry Series, http://factfinder.census.gov/servlet/FindEconDatasetsServlet?ds_name=EC0200A1&_lang=en&_ts=164989593511, Table 2, data on value added in manufacture. The number of employees from the *2002 Economic Census* is also used.

2002 forward: EIA unpublished data from Form EIA-846, "2002 Manufacturing Energy Consumption Survey," national data on quantities purchased, quantities consumed as fuel, and expenditures for pulping liquor, agricultural waste, wood harvested from trees, wood refuse and byproducts from mills, and wood and paper refuse, by North American Industry Classifications (NAICS) categories.

1996 through 2000: EIA, SEDS wood and waste consumption by NAICS categories 311221, 311311, 321113, 321912, 322121, 322130, and 337122, developed from the U.S. Department of Commerce, Bureau of the Census, *1997 Economic Census, Industry Series,* http://factfinder.census.gov/servlet/FindEcon DatasetsServlet?ds_name=E9700A1&_lang=en&_ts=164989057292, Table 2, data on value added in manufacture. The number of employees from the *1997 Economic Census* is also used.

1998 through 2001: EIA, unpublished data from Form EIA-846, "1998 Manufacturing Energy Consumption Survey," national data on quantities purchased, quantities consumed as fuel, and expenditures for pulping liquor, agricultural waste, wood harvested from trees, wood refuse and byproducts from mills, and wood and paper refuse, by NAICS categories.

1994 through 1997: EIA, unpublished data from Form EIA-846, "1994 Manufacturing Energy Consumption Survey," national data on quantities purchased, quantities consumed as fuel, and expenditures for

pulping liquor, agricultural waste, wood harvested from trees, wood refuse and byproducts from mills, and wood and paper refuse, by Standard Industrial Classifications (SIC) categories.

1990 through 1995: EIA, SEDS wood and waste consumption by SIC categories 20, 24, 25, 26, and other (SIC 21–23 and 27–30) developed from the U.S. Department of Commerce, Bureau of the Census, *1992 Census of Manufactures, Industry Series,* Table 2, data on value added in manufacture and number of employees.

1990 through 1993: EIA, unpublished data from Form EIA-846, "1991 Manufacturing Energy Consumption Survey," national data on quantities purchased, quantities consumed as fuel, and expenditures for waste materials, pulping liquor, round wood, wood chips, and biomass.

1986 through 1989: EIA, unpublished data from Form EIA-846, "1988 Manufacturing Energy Consumption Survey," national data on inputs of energy for heat, power, and electricity generation, quantities purchased, and expenditures for waste materials, pulping liquor, round wood, wood chips, and biomass by SIC categories.

1986 through 1989: EIA, SEDS wood and waste consumption by Standard Industrial Classification for 1987 developed from the U.S. Department of Commerce, Bureau of the Census, *1992 Census of Manufactures, Industry Series,* Table 2, revised 1987 data on value added in manufacturing and number of employees.

1980 through 1985: EIA, DOE/EIA-0512(85) *Manufacturing Energy Consumption Survey: Consumption of Energy, 1985*, Table 2. National data on inputs of energy for heat, power, and electricity generation for "Major Byproducts" and "Other" by SIC categories.

1980 through 1985: EIA, SEDS wood and waste consumption by Standard Industrial Classification for 1982 developed from the U.S. Department of Commerce, Bureau of the Census, *1982 Census of Manufactures, Industry Series,* Table 2, data on value added in manufacturing and number of employees.

1970 through 1979: EIA, SEDS 1980 State-level prices for industrial wood and waste.

**Consumption**

1970 forward: EIA, State Energy Data System, industrial wood and waste consumption adjusted as described in Section 7, "Consumption Adjustments for Calculating Expenditures," at http://www.eia.gov/emeu/states/_seds_tech_notes. html.

## Electric Power Sector

State-level data on the electric power sector wood and waste consumption are taken from SEDS and are collected on Form EIA-923, "Power Plant Operations Report," and predecessor forms. All electric generation facilities (utilities and nonutility power producers) are required to report consumption on Form EIA-923, but no price data are collected. State and national wood and waste prices in dollars per million Btu are developed for electric utilities from data reported on Federal Energy Regulatory Commission (FERC) Form 1 and from informal correspondence. Taxes are included in the prices for all years. Prices are not available for nonutility power producers.

### *Btu Prices: All Years*

**1989 Forward.** State-level prices for wood and waste used by electric power plants, in dollars per million Btu, are calculated from data obtained from FERC Form 1, FERC Form 423 (through 2007), and Form EIA-412 (through 2000) and by follow-up correspondence to the electric companies that are not required to submit those forms. For States with more than one utility using wood and waste, a consumption-weighted average price is calculated. There are anomalies that are unique to waste used for electric power generation. In some cases of municipal and industrial waste, there is no charge; and in other cases the electric power facilities charge a "tipping fee" for accepting the waste. That is, instead of paying for the fuel, the power plants are paid to take the fuel. For States where all electric power facilities pay nothing for the fuel or charge a fee for receiving it (see Table TN50), a price of zero is assigned. Although the corresponding consumption is included in calculating the average price for all fuels consumed by electric utilities in the State and the United States, the expenditure included is zero.

**Table TN50. Wood and Waste Used by the Electric Power Sector at No Cost or Charged a Fee, 1989 Forward**

| State | Years |
|---|---|
| California | 1989–1993 |
| Connecticut | 1989–2001 |
| Florida | 1999, 2000 |
| Hawaii | 1989, 1990 |
| Montana | 1989–1994 |
| Ohio | 1989–1993 |

Information on nonutility power producers' use of wood and waste became available beginning with 1989 data. Although quantities of wood and waste used by nonutility power producers are available beginning in 1989, prices are not available. The SEDS electric power sector annual average prices for wood and for waste are assigned to the nonutility power producers' consumption for 1989 forward.

**1983 Through 1988.** A U.S. average price in dollars per million Btu is calculated and assigned to all States. The national price is a consumption-weighted average price based on data obtained from FERC Form 1 and Form EIA-412 and by follow-up telephone surveys of the electric utilities that report use of wood and waste for generating electricity.

Prices are erratic for wood and waste used at electric utilities. In addition to the anomalies of no charge for the fuel and the "tipping fee" mentioned above, handling refuse-derived fuel is more labor intensive than handling conventional fossil fuels. The labor expenses are included in the plant's operating costs, not the fuel costs. Wood and waste prices are also erratic because the demand is relatively small and the pricing mechanism, even for a single facility, may change from year to year. A price or quantity change by a single major user affects the national price more significantly than for any other fuel.

**1978 Through 1982.** National average prices are derived from data collected on Federal Power Commission (FPC) Form 423 and published monthly by EIA in *Cost and Quality of Fuels for Electric Utility Plants (C&Q).* For these years, fossil-fueled plants with a combined capacity of 25 megawatts or greater were required to report on FPC Form 423. Annual prices of wood and waste sold to electric utilities are developed as quantity-weighted monthly prices for those plants where wood chips and refuse were used as fuel. Beginning in 1983, the reporting threshold was raised to 50 megawatts, and very few plants reported use of wood and waste on the FPC Form 423 in 1983 and subsequent years.

A detailed review of data in *C&Q* showed that some entries were in error by factors of 10, 100, or 1,000. Accordingly, the following corrections were made. For 1982, the February, March, and April quantities for the Florida Power Corporation are divided by 1,000 to make them 80, 40, and 60 short tons, respectively. The March, April, and May costs for Northern States Power are multiplied by 100 to make them $0.70 per million Btu. For the 5 months from November 1979 through March 1980, the reported quantities of wood delivered to Burlington Electric Co. are divided by 10 in order to place them in the range of 7,980 to 9,390 short tons. For the 8 months from June 1978 through January 1979, seed corn delivered to the Logansport Indiana Electric Department are included in the waste. For February 1978, the reported quantity of wood delivered to the United Power Associates is divided by 1,000 to make it 90 short tons.

**Table TN51. Price Deflators Used for Wood and Waste Prices, 1970–1977**

| Years | Deflator | Years | Deflator |
|---|---|---|---|
| 1970 | 35.1 | 1975 | 49.2 |
| 1971 | 37.1 | 1976 | 52.3 |
| 1972 | 38.8 | 1977 | 55.9 |
| 1973 | 41.3 | 1978 | 60.3 |
| 1974 | 44.9 | | |

**1970 Through 1977.** The annual prices for wood chips and refuse are derived by deflating the 1978 price by using the gross domestic product implicit price deflator based on 1987 dollars. The deflators are shown in Table TN51.

### *Data Sources*

**Prices**

2008 Forward: EIA, data reported on FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others;" http://www.eia.gov/cneaf/electricity/page/ ferc1.html, and follow-up correspondence with the electric utilities that report use of wood and waste for generating electricity.

2001 through 2007: EIA, data reported on FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others;" http://www.eia.gov/cneaf/electricity/page/ferc1.html, FERC Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants;" http://www.eia.gov/cneaf/electricity/ page/ferc423.html, and follow-up telephone calls of the electric utilities that report use of wood and waste for generating electricity.

1983 through 2000: EIA, data reported on FERC Form 1, "Annual Report of Major Electric Utilities, Licensees and Others;" http://www.eia.gov/cneaf/electricity/page/ ferc1.html, Form EIA-412, "Annual Report of Public Electric Utilities;" FERC Form 423, "Monthly Report of Cost and Quality of Fuels for Electric Plants;" http://www.eia.gov/cneaf/electricity/page/ferc423.html, and follow-up telephone calls of the electric utilities that report use of wood and waste for generating electricity.

1978-1982: EIA, *Cost and Quality of Fuels for Electric Utility Plants*, table titled "Wood Chips, Refuse, and Petroleum Coke Used as Fuel by Steam-Electric Plants."

1970-1978: EIA, *Annual Energy Review 1991*, Appendix C, Gross Domestic Product and Implicit Price Deflator.

**Consumption**

1970 forward: EIA State Energy Data System, wood and waste consumed by the electric power sector.